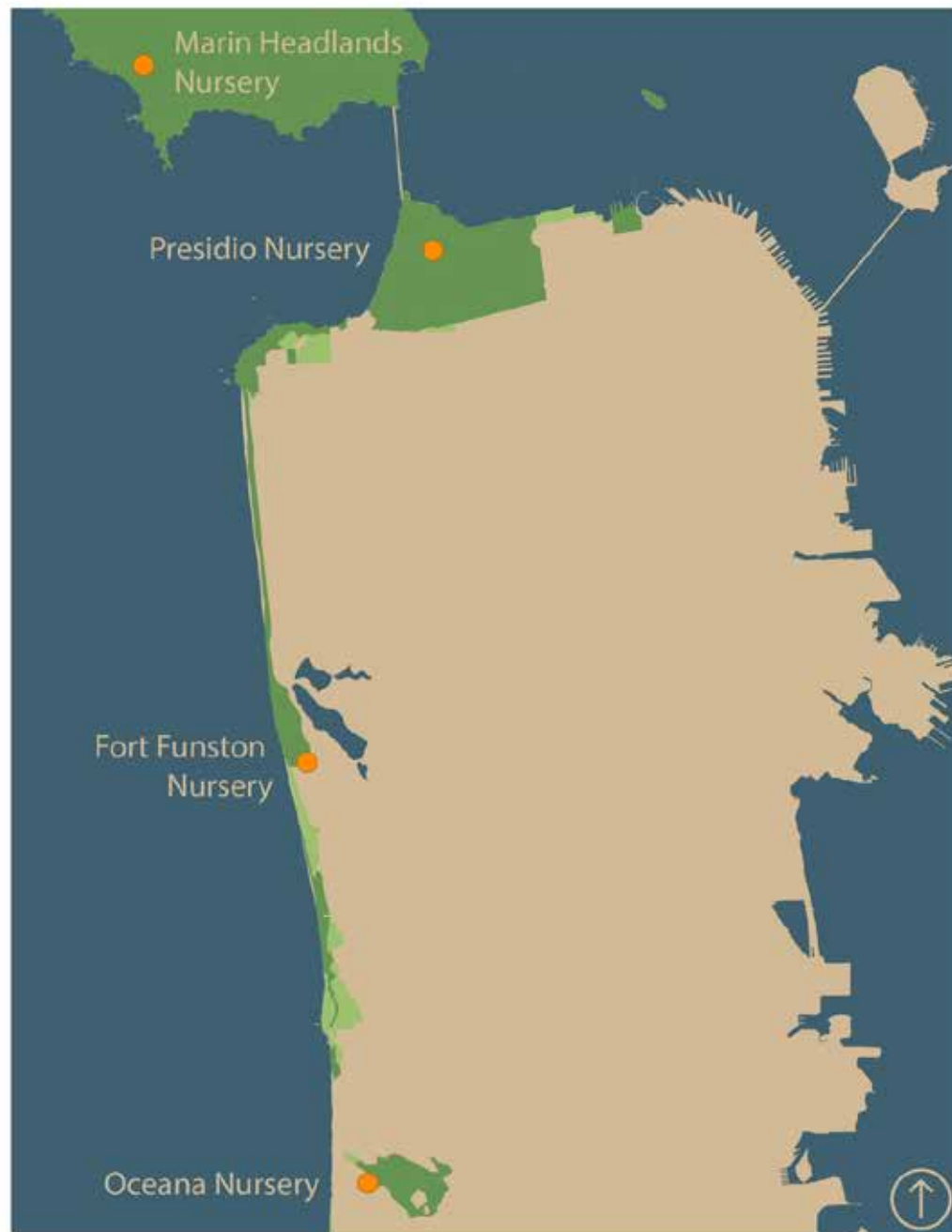


# Nursery Case Study: Implementing the Guidelines to Minimize *Phytophthora* in Restoration Nurseries



Alisa Shor, Director of Park Nurseries  
Golden Gate National Parks Conservancy

















### **Why are we cleaning our boots?**

*Phytophthora* is a genus of fungus-like water molds that are common in nursery, agricultural and landscape settings. Recently there has been increased awareness about several non-native invasive *Phytophthora* species that have been found associated with restoration projects on lands around the Bay Area. We want to be sure we don't spread *Phytophthora* species here in the park, so, as with other invasive species, early detection and rapid response is imperative.

### **What does this mean for you?**

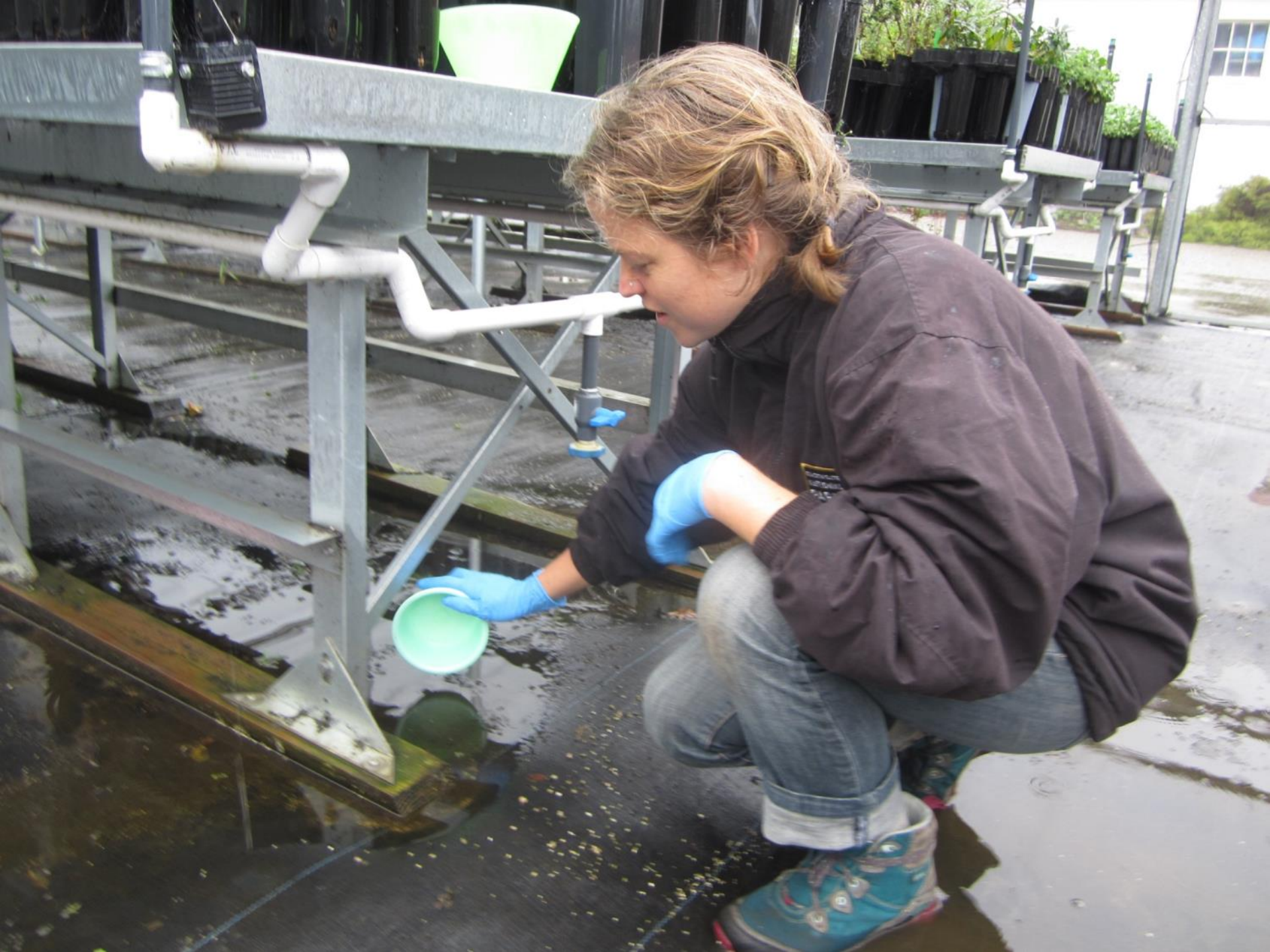
Because pathogens can be in soil, one major way that we can minimize the spread is by sanitizing tools and boots. We have started disinfecting tools and boots with Lysol or rubbing alcohol before and after work days.

If you have questions or comments, please ask your project leaders. We are committed to minimizing the risk of spreading pathogens and we thank you for your support.



































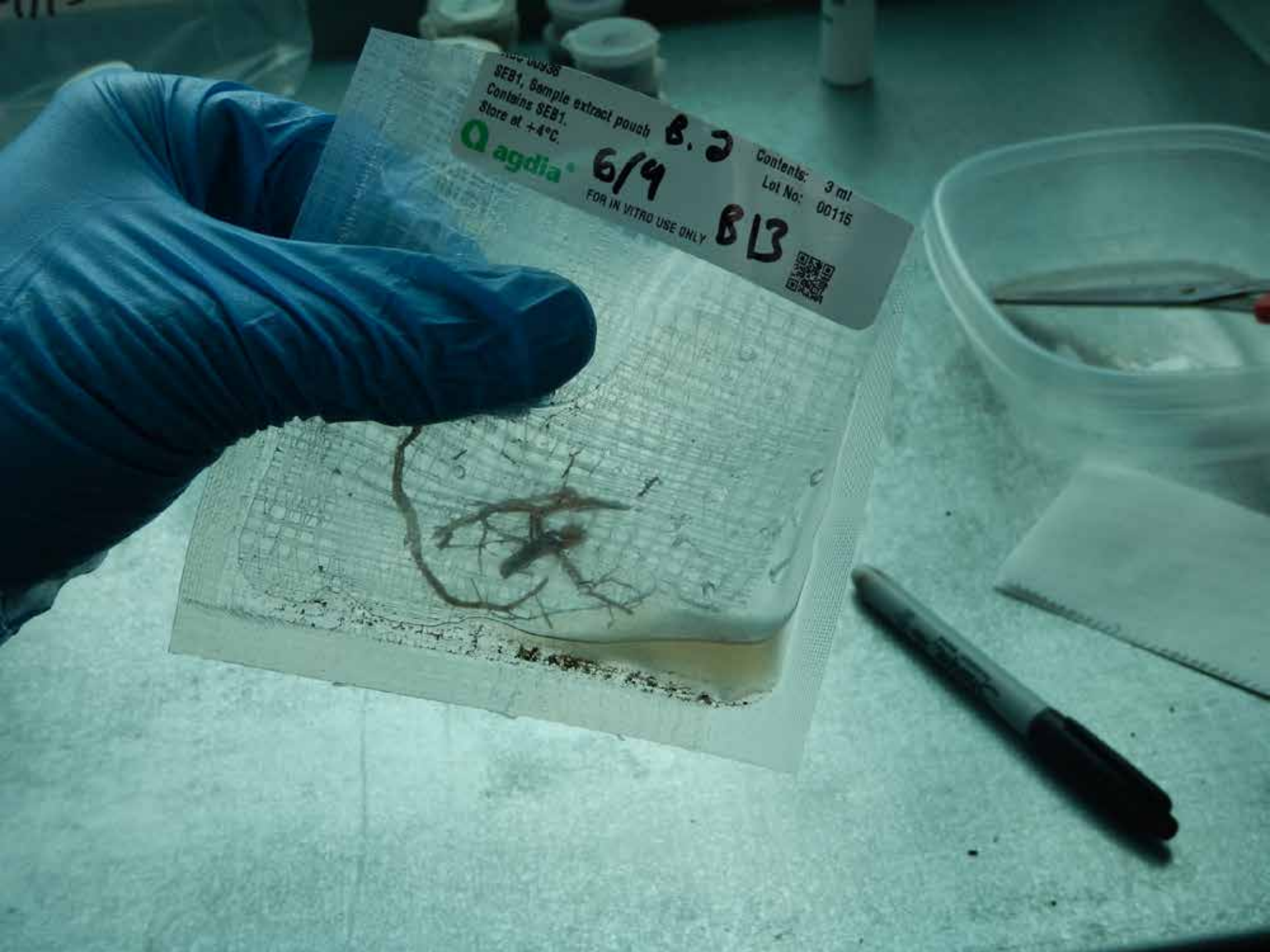


# “High-Risk” Host List – Native Plants

*Acer macrophyllum*  
*Achillea millefolium*  
*Aesculus californica*  
*Alnus rubra*  
*Anaphalis margaritacea*  
*Arbutus menziesii*  
*Arctostaphylos franciscana*  
*Arctostaphylos montana* ssp. *ravenii*<sup>2</sup>  
*Artemisia californica*  
*Artemisia douglasiana*<sup>2</sup>  
*Artemisia pycnocephala*<sup>2</sup>  
*Baccharis douglasii*<sup>2</sup>  
*Baccharis glutinosa*<sup>2</sup>  
*Baccharis pilularis*  
*Castilleja* sp.  
*Ceanothus thrysiflorus*  
*Cornus sericea*  
*Corylus cornuta*  
*Elymus glaucus*  
*Eriogonum latifolia*  
*Eriophyllum confertiflorum*<sup>2</sup>  
*Eriophyllum stachaeifolium*  
*Frangula (Rhamnus) californica*  
*Heteromeles arbutifolia*

*Juncus balticus*<sup>2</sup>  
*Juncus effesus*  
*Juncus falcatus*<sup>2</sup>  
*Juncus lescurii*<sup>2</sup>  
*Juncus patens*  
*Juncus phaeocephalus*<sup>2</sup>  
*Juncus xiphioides*  
*Lonicera hispidula*  
*Lonicera involucrata*  
*Lupinus albifrons*  
*Lupinus arboreus*  
*Lupinus chamissionis*  
*Lupinus formosus*  
*Lupinus variicolor*  
*Mimulus aurantiacus*  
*Morella (Myrica) californica*  
*Pseudotsuga menziesii*  
*Quercus agrifolia*  
*Rhododendron macrophyllum*  
*Rhododendron occidentale*  
*Rubus parviflorus*<sup>2</sup>  
*Rubus ursinus*  
*Umbellularia californica*





SEB1, Sample extract pouch  
Contains SEB1.  
Store at +4°C.

QIAgen

6/9

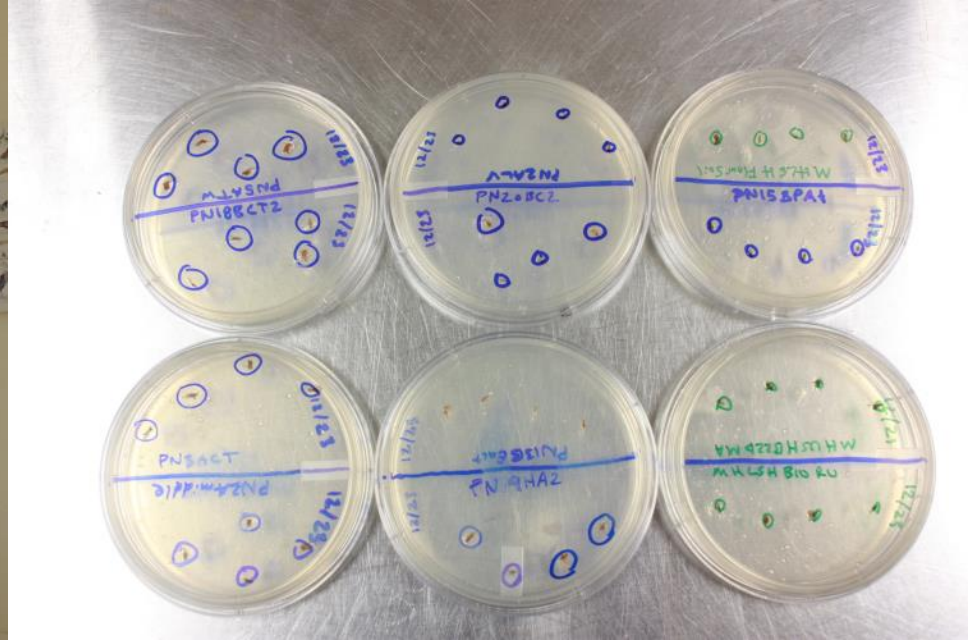
B. 2

Contents: 3 ml  
Lot No: 00115

B13

FOR IN VITRO USE ONLY







| Commercially Grown Ornamental Species    | Agdia Results:            |                             |                         | Baiting (Whole Pears)          | Baiting (Pear Pieces):    | Effluent Testing:              |                        |
|------------------------------------------|---------------------------|-----------------------------|-------------------------|--------------------------------|---------------------------|--------------------------------|------------------------|
|                                          | Roots & Soil (Composite): | Roots & Soil (Pear Pieces): | Effluent (Pear Pieces): | Roots & Soil (Composite):      | Roots & Soil (Composite): | Baiting (Whole Pear):          | Baiting (Pear Pieces): |
| Pittosporum tenuifolium-15 Gallon        | Negative                  | Negative                    | Negative                | Pythium                        | Pythium                   | Pythium                        | Pythium                |
| Leptospermum laevigatum- 15 Gallon       | Negative                  | Positive                    | Negative                | Phytophthora cinnamomi         | Pythium                   | Pythium                        | Phytophthora cinnamomi |
|                                          |                           |                             |                         |                                |                           |                                |                        |
| Pittosporum tenuifolium-5 Gallon         | Negative                  | Negative                    | Negative                | Negative                       | Pythium                   | Pythium                        | Pythium                |
| Leptospermum laevigatum- 5 Gallon (1/3)  | Not Taken                 | Not Taken                   | Negative                | Not Taken                      | Not Taken                 | Phytophthora cactorum          | Pythium                |
| Leptospermum laevigatum- 5 Gallon (2/3)  | Not Taken                 | Not Taken                   | Negative                | Not Taken                      | Not Taken                 | Phytophthora citricola complex | Pythium                |
| Leptospermum laevigatum- 5 Gallon* (3/3) | Positive                  | Positive                    | Positive                | Phytophthora cryptogea complex | Pythium                   | Phytophthora cryptogea complex | Pythium                |
|                                          |                           |                             |                         |                                |                           |                                |                        |
| Pinus muricata (field sample)            | Positive                  | Positive                    | Not Taken               | Phytophthora cactorum          | Pythium                   | Not Taken                      | Not Taken              |
|                                          |                           |                             |                         |                                |                           |                                |                        |
| Rumohra adiantiformis                    | Negative                  | Not Done                    | Negative                | Not Done                       | Pythium                   | Negative                       | Pythium                |
| Pieris japonica**                        | Negative                  | Not Done                    | Negative                | Not Done                       | Pythium                   | P. nicotianae; P. multivora    | P. multivora           |
| Choisya ternata**                        | Positive                  | Not Done                    |                         | Not Done                       | Pythium                   |                                |                        |
| Arbutus marina multi                     | Negative                  | Not Done                    | Negative                | Not Done                       | Pythium                   | Negative                       | Negative               |
| Lepotospermum laveigatum                 | Positive                  | Not Done                    | Positive                | Not Done                       | Pythium                   | P. multivora                   | Pythium                |
| Phorium x Maori Queen                    | Negative                  | Not Done                    | Positive                | Not Done                       | Negative                  | Negative                       | Pythium                |
| Lecuodendron (Safari Sunset)             | Negative                  | Not Done                    | Negative                | Not Done                       | Pythium                   | P. cinnamomi                   | Pythium                |
| Corea                                    | Positive                  | Not Done                    | Positive                | Not Done                       | Pythium                   | P. nicotianae; P. cryptogea    | Pythium                |
|                                          |                           |                             |                         |                                |                           |                                |                        |
| Arbutus marina***                        | Positive                  | Not Done                    | Positive                | Not Done                       | P. nicotianae             | P. nicotianae                  | Pythium                |





# Nursery Sampling Data

| Nursery          | Prod. Year | # of Plants From Which Material Was Collected | # of Samples Analyzed | # of Positive Phytophthora Detections | Percent Positive Detections |
|------------------|------------|-----------------------------------------------|-----------------------|---------------------------------------|-----------------------------|
| Presidio         | 2014       | 1925                                          | 202                   | 16                                    | 8%                          |
|                  | 2015       | 852                                           | 141                   | 0                                     | 0%                          |
|                  | 2016       | 742                                           | 162                   | 0                                     | 0%                          |
|                  |            |                                               |                       |                                       |                             |
| Fort Funston     | 2014       | 22                                            | 22                    | 2                                     | 9%                          |
|                  | 2015       | 450                                           | 84                    | 1                                     | 1%                          |
|                  | 2016       | 100                                           | 71                    | 0                                     | 0%                          |
|                  |            |                                               |                       |                                       |                             |
| Marin Headlands  | 2014       | 38                                            | 38                    | 0                                     | 0%                          |
|                  | 2015       | 1100                                          | 116                   | 0                                     | 0%                          |
|                  | 2016       | 401                                           | 111                   | 0                                     | 0%                          |
|                  |            |                                               |                       |                                       |                             |
| Oceana           | 2014       | 11                                            | 11                    | 0                                     | 0%                          |
|                  | 2015       | 50                                            | 36                    | 0                                     | 0%                          |
|                  | 2016       | 20                                            | 20                    | 0                                     | 0%                          |
|                  |            |                                               |                       |                                       |                             |
| Tennessee Valley | 2014       | 34                                            | 34                    | 4                                     | 12%                         |
|                  | 2015       | 400                                           | 374                   | 17                                    | 5%                          |
|                  | 2016       | -                                             | -                     | -                                     | -                           |

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|                  | 2016       | -                                             | -                     | -                                     | -                           |

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| Nursery          | Prod. Year | # of Plants From Which Material Was Collected | # of Samples Analyzed | # of Positive Phytophthora Detections | Percent Positive Detections |
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| Tennessee Valley | 2014       | 34                                            | 34                    | 4                                     | 12%                         |
|                  | 2015       | 400                                           | 374                   | 17                                    | 5%                          |
|                  | 2016       | -                                             | -                     | -                                     | -                           |

# Nursery Sampling Data

| Nursery                              | Prod. Year | # of Plants From Which Material Was Collected | # of Samples Analyzed | # of Positive Phytophthora Detections | Percent Positive Detections |
|--------------------------------------|------------|-----------------------------------------------|-----------------------|---------------------------------------|-----------------------------|
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|                                      | 2015       | 852                                           | 141                   | 0                                     | 0%                          |
|                                      | 2016       | 742                                           | 162                   | 0                                     | 0%                          |
|                                      |            |                                               |                       |                                       |                             |
| Fort Funston                         | 2014       | 22                                            | 22                    | 2                                     | 9%                          |
|                                      | 2015       | 450                                           | 84                    | 1                                     | 1%                          |
|                                      | 2016       | 100                                           | 71                    | 0                                     | 0%                          |
|                                      |            |                                               |                       |                                       |                             |
| Marin Headlands                      | 2014       | 38                                            | 38                    | 0                                     | 0%                          |
|                                      | 2015       | 1100                                          | 116                   | 0                                     | 0%                          |
|                                      | 2016       | 401                                           | 111                   | 0                                     | 0%                          |
|                                      |            |                                               |                       |                                       |                             |
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|                                      | 2015       | 50                                            | 36                    | 0                                     | 0%                          |
|                                      | 2016       | 20                                            | 20                    | 0                                     | 0%                          |
|                                      |            |                                               |                       |                                       |                             |
| Tennessee Valley<br>(closed in 2016) | 2014       | 34                                            | 34                    | 4                                     | 12%                         |
|                                      | 2015       | 400                                           | 374                   | 17                                    | 5%                          |
|                                      | 2016       | -                                             | -                     | -                                     | -                           |



# Nursery Sampling Data

| Nursery          | Prod. Year | # of Plants From Which Material Was Collected | # of Samples Analyzed | # of Positive Phytophthora Detections | Percent Positive Detections |
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|                  | 2015       | 50                                            | 36                    | 0                                     | 0%                          |
|                  | 2016       | 20                                            | 20                    | 0                                     | 0%                          |
| Tennessee Valley | 2014       | 34                                            | 34                    | 4                                     | 12%                         |
|                  | 2015       | 400                                           | 374                   | 17                                    | 5%                          |
|                  | 2016       | -                                             | -                     | -                                     | -                           |

# 2014-2015 Nursery Detections

## 19 Native plant host detections:

- *Achillea millefolium*
- *Aesculus californica*
- *Alnus rubra*
- *Arctostaphylos franciscana*
- *Castilleja* sp.
- *Ceanothus thrysiflorus*
- *Cornus sericea*
- *Corylus cornuta*
- *Eriogonum latifolia*
- *Frangula* (*Rhamnus*) *californica*
- *Heteromeles arbutifolia*
- *Juncus effesus*
- *Juncus xiphioides*
- *Lonicera hispidula*
- *Lonicera involucrata*
- *Myrica* (*Morella*) *californica*
- *Quercus agrifolia*
- *Rhododendron occidentale*
- *Rubus ursinus*

## 9 *Phytophthora* species detected on nursery container stock:

- *P. cactorum*
- *P. citricola*
- *P. crassamura*
- *P. cryptogea*
- *P. hedraiaandra*
- *P. megasperma*
- *P. multivora*
- *P. plurivora*
- *P. sp.*

2 species not detected in the field to date:  
*P. plurivora* and *P. citricola*





# Commercial Nursery Detections

- **Phytophthora detections on 32 species of commercial nursery container stock that was not grown with BMPs**
- **30 positive detections from 109 samples.**
- **13-20 Phytophthora species detected on commercial nursery stock:**
  - *P. cactorum*
  - *P. cinnamomi*
  - *P. citricola* complex
  - *P. cryptogea*
  - *P. cryptogea* complex
  - *P. dreschleri*
  - *P. multivora*
  - *P. nicotianae*
  - *P. palmivora*
  - *P. parvispora*
  - Close to *P. nicotianae*
  - Close to *P. niederhauserii*
  - Close to *P. sansomeana*
  - Multiple Phyt detections identifiable/unspecified

Ziploc  
A Family Company  
Use Entrapped Air to Seal

Ziploc<sup>®</sup>  
MP

1-19-2015

4163904

544 P63

#5 BAP/



# Field Detections

## 15 Native plant host detections:

- *Achillea millefolium*
- *Anaphalis margaritacea*
- *Artemisia californica*
- *Baccharis pilularis*
- *Ceanothus thrysiflorus*
- *Elymus glaucus*
- *Eriophyllum stachaedifolium*
- *Frangula (Rhamnus) californica*
- *Heteromeles arbutifolia*
- *Juncus patens*
- *Juncus effusus*
- *Lupinus arboreus*
- *Mimulus aurantiacus*
- *Myrica (Morella) californica*
- *Quercus agrifolia*
- *Stuckenia pectinata*

## 15-20 *Phytophthora* species detected in field samples:

- *P. cactorum*
- *P. cambivora*
- *P. crassamura*
- *P. cryptogea*
- *P. drechsleri*
- *P. gonapodyides*
- *P. hedraiandra*
- *P. inundata*
- *P. kelmania*
- *P. megasperma*
- *P. multivora*
- *P. Pg chlamydo*
- *P. rosacearum*
- *P. thermophila*
- Multiple Phyt detections identifiable/unspciated

8 species not detected in the nursery to date: *P. cambivora*, *P. inundata*, *P. drechsleri*, *P. Pg clamydo*, *P. thermophila*, *P. gonopodyides*, *P. rosacearum*, and *P. kelmania*

# Costs: December 2014 to Present

| Expense Type                             | Total to Date    |
|------------------------------------------|------------------|
| Sanitation Supplies, Equipment and Misc. | \$35,457         |
| Consultant Fees                          | \$40,576         |
| Lab Fees and Testing Expenses            | \$78,975         |
| Capital Improvements                     | \$211,867        |
| Estimated Value of Plants Destroyed      | \$123,500        |
| Estimated Labor—Nursery Staff Only       | \$307,700        |
| <b>TOTAL</b>                             | <b>\$798,075</b> |

# Estimated Future Costs

| Expense Type                                           | Total to Date    |
|--------------------------------------------------------|------------------|
| Sanitation Supplies—Ongoing Annual                     | \$8,500          |
| Testing 2017 Plant Lots                                | \$3,000          |
| Capital Improvements for Infrastructure and Sanitation | \$130,000        |
| Labor—Nursery Staff Only Ongoing Annual                | \$140,000        |
| <b>TOTAL</b>                                           | <b>\$281,500</b> |











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- History
- Branches of life
- Systematics
- How do we know how we know it?
- Why?
- Evolutionary systematics
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# We Can Do It!



POST FEB. 15 TO FEB. 28



WAR PRODUCTION CO-ORDINATING COMMITTEE

## Golden Gate National Parks Conservancy

Anna Murray  
Annette Russell  
Brian Teng  
Christina Crooker  
Desmond Murray  
Ely Huerta Ortiz  
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## National Park Service

Alison Forrestel



Presidio  
Trust

## Presidio Trust

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Amy Mautz  
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Michelle Krieg, Friends of Sausal Creek

## San Francisco Recreation and Parks

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## Working Group on Phytophthoras in Native Habitats

Greg Lyman, San Francisco Public Works Commission  
Janell Hillman, Santa Clara Valley Water District  
Janice Alexander, UC Cooperative Extension, Marin County  
Karen Suslow, National Ornamental Research Site, Dominican University of California  
Laura Lee Sims, UC Berkeley Forest Pathology and Mycology Lab  
Mia Ingolia, San Francisco Public Works Commission  
Susan Frankel, US Forest Service, Pacific Southwest Research Station  
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